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(54) Compositions with a base of vinylidene fluoride copolymers including polyvinyl chloride and their use in cables.

(57) Compositions with a base of vinylidene fluoride copolymers and ethylenically-unsaturated fluorinated comonomers containing at least 75% by weight of vinylidene fluoride including polyvinyl chloride and an effective amount of a methacrylic polymer (compatibility). These compositions show improved dielectric properties which makes them particularly interesting for jacketing of electric cables.

DESCRIPTION

This invention involves compositions with a base of vinylidene fluoride and polyvinyl chloride copolymers, as well as their use in jacketing of electric cables. It involves in particular compositions also containing a methacrylic polymer.

In the application for patent EP-A-O 294 755, compositions are described for coating of various substrates in order to produce adhesive and hard coatings having excellent chemical resistance and which include, for 100 parts in all, (A) 10 to 95 parts of vinylidene fluoride resin, (B) from 1 to 80 parts of a resin with a low compatibility with the vinylidene fluoride resin and (C) from 1 to 30 parts of resin with excellent compatibility with resins (A) and (B), generally an acrylic or methacrylic resin. Polyvinyl chloride is cited among the (B) resins useable in the compositions, but all examples of implementation use a resin (B) of a hardening type containing reactive functional groups such as an epoxy resin, a phenol resin, etc. These compositions are applied on substrates in solution or dispersion in the organic solvents, then cooked at high temperature to form an adhesive film on the substrate.

The purpose of this invention is to obtain compositions with a base of vinylidene fluoride copolymers which have improved dielectric properties.

It is well known that vinylidene fluoride polymers, homopolymers and copolymers with halogenated comonomers, have a high limiting oxygen index and low flame propagation, in other words, a high resistance to fire and besides, a very low smoke emission. They release very little smoke during combustion. In addition to these attractive properties of fire resistance, they add a high resistance to thermal aging, that is to say their mechanical properties such as elongation and tensile stress at break are not significantly modified after prolonged thermal aging at temperatures greater than 100 °C.

It is precisely for this group of interesting properties that the vinylidene fluoride polymers and especially its copolymers with halogenated comonomers, generally more flexible than the homopolymers, find applications in the area of jacketing of electric cables and fiber optics. Nonetheless, vinylidene fluoride polymers have dielectric properties which are not optimal and in particular a dielectric constant and relative high dielectric loss at high frequency (that is greater than 1 MHz).

Vinyl chloride polymers, more specifically, polyvinyl chloride, have more interesting dielectric properties than the vinylidene fluoride polymers and in particular a lower dielectric constant and dielectric losses at high frequency (> 1 MHz). To this end, they have already been proposed for jacketing of electric cables. Nonetheless, vinyl chloride polymers have a fire resistance, especially a limiting oxygen index, that is lower and thus higher flammability, than the vinylidene fluoride polymers. Also, during their combustion, they clearly emit more smoke than vinylidene fluoride polymers. Also, it is generally necessary to incorporate into them significant amounts of plasticizers to give them the flexibility necessary for jacketing of

cables, which generally decreases their fire resistance and increases their smoke emission.

The purpose of this invention is to obtain compositions with a base of vinylidene fluoride copolymers and vinyl chloride polymers useable, especially, for jacketing of electric cables, which do not have any of the problems cited above and which, in particular, have excellent dielectric properties, excellent resistance to thermal aging and fire resistance.

To this end, the invention involves compositions with a base of vinylidene fluoride copolymers with improved dielectric properties, characterized by the fact that they are made up essentially of a thermoplastic copolymer of vinylidene fluoride and ethylenically unsaturated fluorinated comonomers containing at least 75% by weight of monomer units derived from vinylidene fluoride and polyvinyl chloride, as well as an effective amount of methacrylic polymer.

The methacrylic polymer present in the compositions according to the invention is chosen from among methyl methacrylate homopolymers and its copolymers with a preponderant amount in methyl methacrylate with alkyl acrylates and/or methacrylates. Positive results are obtained with methyl methacrylate copolymers and C2-C6 alkyl acrylates. Excellent results are obtained with methyl methacrylate and C2-C4 alkyl acrylate copolymers, such as for example butyl acrylate.

The amount of methyl methacrylate copolymers is generally at least about 55% by weight and preferably at least about 60% by weight. Generally it does not exceed about 90% by weight, and most often it does not exceed 80% by weight.

Advantageously, the average molecular weight of the methacrylate polymer is such that a solution containing 2 grams of polymer per liter of cyclohexanone has, at 25°C, a relative viscosity at least equal to 1. Generally, relative viscosity at 25 °C of this solution does not exceed 3. Preferably, the relative viscosity at 25° C, of a solution of 2 grams of polymer per liter of cyclohexanone is between approximately 1.4 and 2.2.

By effective amount of methacrylic polymer, we mean an amount which is at least enough to ensure compatibility between the vinylidene fluoride copolymer and polyvinyl chloride as is shown, for example, by the presence of a single peak of glass transition temperature for the blend. The optimum amounts of methacrylic polymer depend basically on the chemical composition of the methacrylic polymer and the respective amounts of vinylidene fluoride copolymer and polyvinyl chloride in the compositions according to the invention. They will thus be advantageously evaluated in each special case by experiments. To give an idea, the amount of methacrylic polymer generally amounts to at least about 2 parts by weight and, most often to at least about 4 parts by weight for 100 parts by weight total of the vinylidene fluoride and the polyvinyl chloride copolymer. Generally, this amount does not exceed abut 20 parts by weight, most often it does not exceed about 15 parts by weight for 100 parts by weight total of vinylidene fluoride and polyvinyl chloride copolymer.

The thermoplastic copolymers of vinylidene fluoride, hereinafter called co-PVDF, used in the compositions of the invention, advantageously present a melting point at least equal to about 130°C and preferably, at least equal to about 150 °C and even more so, at least equal to 165 °C. As examples of useable fluorinated comonomers, we note in particular hexafluoropropylene and chlorotrifluoroethylene, preferably the latter.

An advantageous variation of this invention is when the co-PVDF is a copolymer of vinylidene fluoride and hexafluoropropylene containing from about 5 to 20% by weight of hexafluoropropylene and even more so from about 8 to 15% by weight. These latter copolymers have melting points from about 160 to about 135 °C.

A very advantageous variation of this invention is when the co-PVDF is a vinylidene fluoride and chlorotrifluoroethylene copolymer containing about 10 to 25% by weight of chlorotrifluoroethylene and even more so, 12 to 22% by weight approximately. These latter copolymers, which are preferable, present melting points of about 170 to 165°C.

The method for obtaining fluorinated copolymers is not critical. Thus they can be made from any of the known and usual processes for preparing vinylidene fluoride copolymers such as, for example, polymerization in aqueous emulsion, in aqueous suspension or in aqueous dispersion still called aqueous microsuspension. Also, they can be homogeneous (regular distribution of monomer units in the comonomer within the polymer chains) or heterogeneous (irregular distribution of the monomer units within the polymer chains of the copolymer).

The copolymers preferably used in compositions according to the invention are advantageously obtained from copolymerization in aqueous suspension with use of totality of vinylidene fluoride and chlorotrifluoroethylene from copolymerization (which leads to heterogeneous copolymers) and in the presence of usual ingredients of this type of polymerization, which is essentially a dispersing agent (such as, for example, ethylhydroxyethylcellulose), an oil soluble catalyst (such as for example, tert-amyle parplvalate) and an agent to regulate the chains (such as, for example, diethyl carbonate).

By polyvinyl chloride, we mean, for the purposes of this invention, vinyl chloride homopolymers and its copolymers containing a maximum of about 25% by weight of ethylenically unsaturated comonomers. These copolymers can be random copolymers, block copolymers or even copolymers grafted onto any polymer trunk. Some examples of vinyl chloride comonomers are olefins such as ethylene and propylene and esters such as vinyl acetate and alkyl acrylates and methacrylates. The polyvinyl chloride used in the invention compositions can be obtained by any known polymerization process such as polymerization in suspension or in aqueous emulsion. Most often, it has a K number (measured at 25 °C in cyclohexane at 5 g/l) of about 50 to about 80.

The compositions in the invention contain a preponderant amount of co-PVDF compared to polyvinyl chloride (PVC). The ratio by weight of the vinylidene fluoride copolymer to the polyvinyl chloride (co-PVDF/PVC) present in the compositions is generally at least equal to 1.20 and

most often equal to at least 1.5. Excellent results are obtained with a weight ratio of co-PVDF/PVC at least equal to 1.8.

Generally, the co-PVDF/PVC weight ratio does not exceed 9. Most often, this ratio does not exceed 6. Excellent results are obtained with a weight ratio for co-PVDF/PVC which does not exceed 4.

Aside from the vinylidene fluoride (co-PVDF) and vinyl chloride (PVC) polymers and the methacrylic polymer defined above and which represents the essential constituents of the invention compositions, these can of course contain all the usual ingredients used in each of the polymers making up the invention compositions (such as thermal stabilizers, lubricants, and perhaps plasticizers) as well as various additives such as fillers, pigments and/or colorants, fireproofing agents, smoke reducing agents, etc.

It can be useful to incorporate small amounts of plasticizers into the compositions in the invention in order to avoid any problem of melt flow weld during start-up. To do this, we can use one or more of the typical plasticizers for vinylidene fluoride and vinyl chloride polymers, such as for example the phthalates and dialkyl sebacates (such as dioctyl and diethylhexyl phthalates and dibutyl sebacate) or even plasticizers such as polyesters derived from alkenedicarboxylic acids (such as adipic acids, azelaic or sebaceous acids) and diols, especially aliphatic diols and which have molecular weights of at least about 1500, preferably at least 1800 and which do not exceed about 5000, preferably less than 3500. The polyester plasticizers are especially suitable. The amount of plasticizer generally does not exceed 15% by weight of the total composition and most often not 12% by weight of the total composition.

While the blends of vinylidene fluoride and polyvinyl chloride copolymers free from methacrylic polymer are heterogeneous (dispersion of coarse nodules of polyvinyl chloride in the continuous phase of the vinylidene fluoride copolymer) and produce articles made from them that have a rough surface appearance, the compositions in the invention are perfectly homogeneous and produce articles made from them that have a smooth and glossy surface appearance.

A surprising effect of the invention compositions lies in the fact that with the incorporation of an effective amount of methacrylic polymer, compositions with a base of vinylidene fluoride copolymers include polyvinyl chloride in minor amounts with dielectric properties, especially a substantially improved dielectric constant and dielectric losses compared to compositions exclusively with a base of co-PVDF and are close to those of the compositions exclusively with a base of polyvinyl chloride.

The compositions in the invention can be made in any known and usual way to blend the polymers and their various ingredients for start-up and additives. They can, for example, be made by blending, in one or several operations, all the ingredients in a rapid mixer at low temperature to produce non-pre-gelled compositions in flake form, generally called premixes. They can also be made by blending, in one or more steps, all the ingredients in an extruder in which the blend is at a temperature at least equal to the melting point of co-PVDF to produce pre-gelled blends generally called compounds. Advantageously,

the compositions in the invention are in the compound state (pre-gelled blend) and in particular in the form of pellets/granules.

The invention compositions can be used with any classic technique for processing plastics in the melt state, such as extrusion and injection. They are especially suitable for use with extrusion.

The objects made with the compositions in the invention have a group of interesting properties. They combine excellent dielectric properties with excellent mechanical properties, even after thermal aging. Finally, if their fire resistance properties (flame propagation, smoke emission, etc.) are somewhat reduced compared to objects made with compositions containing exclusively vinylidene fluoride copolymers, they are still completely adequate to meet generally severe safety standards imposed for cable applications.

The compositions in the invention are suitable for fiber optic jacketing. They are especially suitable for jacketing of electric cables such as communication cables. The use of compositions in the invention for jacketing of electric cables constitutes another aspect of this invention.

The following examples illustrate the invention.

Example 1

This example involves a composition in which the vinylidene fluoride copolymer is a copolymer of vinylidene fluoride and chlorotrifluoroethylene containing 15% weight chlorotrifluoroethylene and a melting point of 169°C and an MFI of about 5 g/10 min at 230 °C under 2.16 kg (ASTM D 1238).

The vinyl chloride polymer is a vinyl chloride homopolymer with a K number of 71 (measured at 25 °C in cyclohexanone at 5 g/l).

The methacrylic polymer is a copolymer of methyl methacrylate and butyl acrylate containing 63% by weight of methyl methacrylate and for which a solution at 2 g/liter of cyclohexanone has a relative viscosity at 25 °C of 1.96.

The composition illustrating the invention was prepared by extrusion in a double-screw extruder at 180-200 °C of 60 parts by weight of VF2-CTFE copolymer pellets formulated (whose detailed composition is shown below = composition A) with 40 parts by weight of polyvinyl chloride pellets formulated (whose detailed composition is also shown below - composition B) and with 10 parts of methacrylic copolymer (in flakes) whose composition is shown above.

COMPOSITION A (parts by weight)	
VF2-CTFE copolymer	100
Calcium molybdate	5
Precipitated calcium carbonate coated with stearic acid	0.1
Polyethylene wax	0.2

COMPOSITION B (parts by weight)	
Polyvinyl chloride	100
Phthalates (plasticizers)	46
Thermal stabilizers (with lead)	6
Kaolin (filler)	7
Polyethylene wax	0.7
Antimony oxide	4

Pellets extruded from 60 parts by weight of composition A, 40 parts by weight of composition B and 10 parts by weight of methacrylic copolymer contain 11 parts by weight of methacrylic polymer for 100 parts by weight total of co-PVDF and PVC and presenting a ratio by weight for co-PVDF/PVC of 2.3.

From these pellets, we pressed sheets 2 mm thick (material temperature: about 200° C) on which dielectric properties (constant and dielectric loss) and fire resistance (LOI - Limiting oxygen index) and smoke emission (maximum density with and without flame) were evaluated according to standards (ASTM). Results of these evaluations are included in the Table attached.

Also, from these pellets we extruded, on a single-screw extruder, 2-mm-thick strips (material temperature: about 200 °C) on which tensile mechanical properties (tensile stress and elongation at break) were evaluated using standards (ASTM and UL). Results of these evaluations are also shown in the Table in the attachment. For mechanical properties, the figures provided make up the average value of the five test pieces.

As a comparison, results from composition A (see above) made up basically of co-PVDF and free of PVC and methacrylic polymer were also shown.

Comparison of results showed the clear improvement of dielectric properties while maintaining mechanical tensile properties at values

close to those from compositions exclusively with a base of vinylidene fluoride copolymer.

Example 2

This example involves a composition in which the vinylidene fluoride copolymer is a copolymer of vinylidene fluoride and chlorotrifluoroethylene containing 20% by weight of chlorotrifluoroethylene and has a melting point of 165 °C and an MFI of about 5 g/10 minutes at 230 °C, under 2.16 kg (ASTM D 1238).

The vinyl chloride polymer is a vinyl chloride homopolymer with a K number of 64 (measured at 25 °C in cyclohexanone at 5 g/l).

The methacrylic polymer is identical to the one used in example 1.

The composition in the invention was prepared by extrusion in a double-screw extruder at 180-200 °C of 73 parts by weight of pellets of the VF2-CTFE copolymer made (whose detailed composition is shown below- composition A) with 27 parts by weight of polyvinyl chloride pellets (detailed composition shown below - composition B).

COMPOSITION A (parts by weight)	
VF2-CTFE Copolymer	100
Calcium molybdate	0.45
Precipitated calcium carbonate coated with stearic acid	0.15
Polyethylene wax	0.30
Adipic polyester with average molecular weight of about 3000 (plasticizer)	7
Methacrylic copolymer	7

COMPOSITION B (parts by weight)	
Polyvinyl chloride	100
Thermal stabilizers (with lead)	10
Calcium stearate	2
Hydrogenated castor oil	3
Calcium carbonate	20

The pellets extruded in this way contain about 5 parts by weight of methacrylic copolymer for 100 parts by weight in all of co-PVDF and PVC and have a weight ratio of co-PVDF/PVC of about 3.3.

From these pellets, we pressed 2-mm-thick sheets (material temperature: about 200 °C) on which we evaluated the following dielectric properties using the ASTM D 150 standard:

Dielectric constant	at 1 MHz : 5.2
	At 10 MHz : 4.1
Dielectric loss	at 1 MHz : 0.6
	At 10 MHz : 0.6

TABLE

PROPERTIES EVALUATED		Type of sample	Standard	Units	Example - Invention	Comparison Sample (Composition A)
DIELECTRIC PROPERTIES						
Dielectric constant	At 1 MHz	Pressed plates (2 mm)	ASTM D 150	-	4.6	7.5
	At 10 MHz	"	"	-	3.8	4.9
Dielectric Loss	At 1 MHz	"	"	-	0.4	1.5
	At 10 MHz	"	"	-	0.4	1.5
MECHANICAL PROPERTIES						
Tensile Stress at break		Extruded strip (2 mm)	ASTM D638	Mpa	32	27
% maintained after aging for 7 days at 136°C		"	UL 444	%	≈ 90	≈ 90
Elongation at break		"	ASTM D638	%	427	565
% maintained after aging for 7 days at 136°C		"	UL 444	%	≈ 90	≈ 90
FIRE-SMOKE PROPERTIES						
Limiting Oxygen index (LOI)		Pressed sheet (2 mm)	ASTM D2863	%	38	100
Maximum smoke density/g	W/flame	"	ASTM E662	"	11	10
	W/o flame	"	"	"	13	7

CLAIMS

1. Compositions with a base of vinylidene fluoride copolymers with improved dielectric properties, characterized by the fact that they are made up essentially of a thermoplastic copolymer of vinylidene fluoride and ethylenically unsaturated fluorinated comonomers containing at least 75% by weight of monomer units derived from vinylidene fluoride and polyvinyl chloride, as well as an effective amount of methacrylic polymer.

2. Compositions with a base of vinylidene fluoride copolymers cited in claim 1, characterized by the fact that the methacrylic polymer is chosen from methyl methacrylic homopolymers and its copolymers with a preponderance of methyl methacrylate with acrylates and/or C2-C6 alkyl methacrylate.

3. Compositions with a base of vinylidene fluoride copolymers as cited in claim 2, characterized by the fact that the methacrylic polymer is chosen from methyl methacrylic copolymers and C2-C4 alkyl acrylates .

4. Compositions with a base of vinylidene fluoride copolymer as cited in any of the claims 1 to 3, characterized by the fact that the methacrylic polymer contains at least about 55% by weight of the MMA and not more than about 90% by weight.

5. Compositions with a base of vinylidene fluoride copolymers as cited in any of claims 1 to 4, characterized by the fact that the methacrylic polymer is present in ratios of at least 2 parts by weight and not more than about 20 parts by weight for 100 parts by weight total of the vinylidene fluoride and polyvinyl chloride copolymer.

6. Compositions with a base of vinylidene fluoride copolymer as cited in claim 5, characterized by the fact that the methacrylic polymer is present in a ratio of about 4 to about 15 parts by weight for 100 parts by weight total of the vinylidene fluoride and polyvinyl chloride copolymer.

7. Compositions with a base of vinylidene fluoride copolymers as cited in any of claims 1 to 6, characterized by the fact that the vinylidene fluoride copolymer is chosen from among vinylidene fluoride and chlorotrifluoroethylene copolymers containing from 10 to 25% approximately by weight of chlorotrifluoroethylene and vinylidene fluoride and hexafluoropropylene copolymers containing about 5 to 20% by weight of hexafluoropropylene.

8. Compositions with a base of vinylidene fluoride copolymers according to claim 7, characterized by the fact that the vinylidene fluoride copolymer is a copolymer of vinylidene fluoride and chlorotrifluoroethylene containing from about 12 to 22% by weight of chlorotrifluoroethylene.

9. Compositions with a base of vinylidene fluoride copolymers as cited in any of claims 1 to 8, characterized by the fact that the weight ratio of the vinylidene fluoride copolymer to the polyvinyl chloride copolymer is equal to 1.2 at least and does not exceed 9.

10. Compositions with a base of vinylidene fluoride copolymers as cited in any of claims 1 to 9, characterized by the fact that they are present in the state of a compound.

11. Use of compositions with a base of vinylidene fluoride copolymers as cited in any of claims 1 to 10 for jacketing of electric cables.

EUROPEAN SEARCH REPORT

DOCUMENTS CONSIDERED PERTINENT			
Category	Citations of pertinent documents	Claims involved	Classification of request
A	US-A-5 322 899 (Grunewalder et al) *example 1*	1	C08L27/16
P,A	CHEMICAL ABSTRACTS, vol. 122, no. 16 April 17, 1995 Columbus, Ohio, USA; Abstract no. 189846, "flame & impact resistant vinyl chloride polymer compositions" Page 132 "abridged" & JP-A-06 248 141 *SEIKISUI CHEMICAL KK) & October 1994	1	//(C08L27/16, 17:06, 33:10)
A			
This report was drawn up for all claims.			Technical documents searched C08L
The Hague	February 8, 1996	Schueler, D.	

UC13

662318 - COMPOSITION OF VINYLIDENE FLUORIDE COPOLYMER, PVC AND METHACRYLIC RESIN - HAS IMPROVED DIELECTRIC PROPERTIES, ESPECIALLY AS CABLE COVERING FOR HF CABLES

SOLVAY

Demande de Brevet (DBREV)
EP 0709429 (Priorite : 24 Oct 94) (Langue : FR)

96-211000/22 A14 (A85) SOLV 94.10.24
SOLVAY SA *EP 709429-A1
94.10.24 94BE-000957 (96.05.01) C08L 27/16 (C08L 27/16, 27:06, 33:10)

Compsn. of vinylidene fluoride copolymer, PVC and methacrylic resin - has improved dielectric properties, esp. as cable covering for HF cables (Frn)

C96-067460 R(BE DE FR GB IT)
Addnl. Data: THULLIEZ V, LAMBERT Y, LAURENT G, DECLERCK F
95.10.19 95EP-202833

A(4-E3E, 4-E10B, 4-F1A, 7-A2B, 12-E2A) A0175

Vinylidene fluoride copolymer based compsns. having improved dielectric properties comprise (i) thermoplastic copolymer of vinylidene fluoride and ethylenically unsatd. fluorinated comonomers, contg. at least 75 wt.% of monomer units derived from vinylidene fluoride, (ii) PVC and (iii) methacrylic resin as compatibility improving agent.

USE

Esp. as covering materials for cables, including cables for use at high frequencies (greater than 1 MHz).

ADVANTAGE

The compsns. have good fire resistance, low spread of flame and low smoke emission upon exposure to fire, good resistance to ageing at elevated temps., and improved dielectric properties, esp. a low dielectric constant and reduced dielectric loss at high frequencies (greater than 1 MHz) compared to polyvinylidene fluoride alone.

PREFERRED COMPATIBILITY IMPROVER

Pref. the methacrylic resin is chosen from homopolymers of methyl methacrylate (MMA) and copolymers comprising a preponderant amt. of MMA with 2-64 C alkyl (meth)acrylates, esp. copolymers of MMA with 2-4 C alkyl acrylates. Pref. the copolymers contain at least ca. 55 wt.% and not more than ca. 90 wt.% MMA. Pref. the methacrylic resin is used in an amt. of at least ca. 2 pts.wt. and not more than 20 pts.wt., esp. 4-15 pts.wt., per 100 pts.wt. total vinylidene fluoride copolymer and PVC.

PREFERRED POLYMER COMPOSITION

Pref. vinylidene fluoride copolymers are copolymers of vinylidene fluoride with chlorotrifluoroethylene contg. ca. 10-25 (12-22) wt.% chlorotrifluoroethylene, and copolymers of vinylidene fluoride with hexafluoropropylene contg. 5-20 wt.% hexafluoropropylene. Pref. the wt. ratio vinylidene fluoride copolymer to PVC in the compsn. is at least 1.2 and not greater than 9.

EXAMPLE

A mixt. of 100 pts.wt. of a copolymer of vinylidene fluoride and chlorotrifluoroethylene (15 wt.% chlorotrifluoroethylene, m.pt. 169 ° C), 5 pts. Ca molybdate, 0.1 pts. pptd. $CaCO_3$ coated with stearic acid and 0.2 pts. polyethylene wax was compounded and extruded as granules (A). A mixt. of 100 pts. PVC (K-value 71), 46 pts. phthalate plasticisers, 6 pts. Pb heat stabilisers, 7 pts. kaolin filler, 0.7 pts. polyethylene wax and 4 pts. Sb_2O_3 was compounded and extruded as granules (B). A mixt. of 60 pts. granules (A), 40 pts. granules (B) and 10 pts. of a powder copolymer of MMA and butyl acrylate contg. 63 wt.% MMA was extruded at 180-200 ° C through a twin screw extruder to give a compsn. having the following properties in comparison to the polyvinylidene copolymer (compsn. A) alone (in brackets): dielectric constant at 1 MHz 4.6 (7.5); dielectric constant at 10 MHz 3.8 (4.9); dielectric loss at 1 MHz 0.4 (1.5), dielectric loss at 10 MHz 0.4 (1.5); strain at rupture 32 (27) MPa; elongation at rupture 427 (565) %; Oxygen index 38 (100) %; max. smoke density/g ASTM E 662 with flame 11 (10), without flame 13 (7). (PW)
(9pp513DwgNo.0/0)
SR:01Jnl.Ref JP06248141 US5322899